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ABSTRACT

This report discusses in detail the 1988-89 evaluation study developed by the University of California at Los Angeles Center for Technology Assessment and the Apple Classrooms of Tomorrow (ACOT) administration for the purpose of determining the impact of the ACOT project on students, teachers, and parents. Both student achievement in writing and student attitudes toward computers were measured, together with teacher attitudes about curricular practices, student's achievement, and occupational stress, and attitudes of parents about the impact of ACOT on their children. Measurement instruments on attitudes were primarily questionnaires. A norm-referenced achievement test in basic skills and educational development was used to establish a basis for comparison, and a study of written composition was used to rate writing achievement. Results indicate that: (1) there is inconclusive evidence for ACOT contributing to students' achievement at a level beyond that of conventional instruction; (2) the ACOT project neither undermines student interest and motivation, nor enhances affective aspects of their school experience; (3) in spite of the amount of variability among those who responded, it can be determined that ACOT teachers experience considerable personal and professional impact; and (4) response bias among parents limits the ability to infer ACOT effects on parents' views or home activities. Overall satisfaction with the children's progress was reported, and computers appeared to be increasingly integrated with home activities. It is concluded that assessment of ACOT requires new documentation and evaluation tools capable of measuring the complexities of ACOT effects. (DB)

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The Apple Classrooms of Tomorrow™ 1989 Evaluation Study[1]

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Introduction

In 1987, an evaluation design was developed by UCLA Center for Technology Assessment (Baker & Herman, 1987) in conjunction with the ACOT administration. The design is a comprehensive, coordinated, multi-component evaluation of the impact of the ACOT project on ACOT students, staff, and parents. Key attributes of the plan are:

- collection and analysis of a broad range of potential student outcomes;
- collection and analysis of such information over time;
- linking outcome data with information on instructional process and other school context variables to provide explanatory power for findings;
- linking multiple indicators of key outcomes to strengthen the validity of findings;
- combining the strengths of both quantitative and qualitative methodologies;

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[1]This work was partially suported by Apple Computer Company but does not reflect their official position. The work was conducted at the UCLA Center for Technology Assessment and reflects only the opinions of the listed authors.

Special thanks to John Novak, David Niemi, Darlene Galluzzo, Patricia Mutch, Rebecca Frazier, Ulla Olsen, and Tom Marks for creativity and hard work at all points of the process.

- providing uniform data collection strategies and measures across the devise ACOT sites, but reserving places for interests, measures, and effects unique to each site.

Four basic questions guide the work:

1. *What is the impact of ACOT on students?*

2. *What is the impact of ACOT on teachers' practices and classroom processes?*

3. *What is the impact of ACOT on teachers professionally and personally?*

4. *What is the impact of ACOT on parents and home life?*

Multiple methods were selected to collect information bearing on these questions. Data collection was initiated in the spring of 1988 with the administration of a range of student outcome measures to provide a baseline for comparison with subsequent administrations in 1989 and beyond. Student outcomes assessed in that initial year included: (1) achievement on standardized tests, (2) performance in written composition, and (3) student attitudes. These measures are described in the methods section below, and the 1988 baseline results are described in previous reports (Baker, Herman, & Gearhart, 1988; Baker, Herman, & Gearhart, 1989). Our earlier report (Baker, Herman, & Gearhart, 1988) also provides descriptions of the ACOT project, the ACOT sites, UCLA's role in ACOT, and the evaluation model which organizes our work.

Our goals for the 1988-89 evaluation were:

- to complete the process of establishing comparison classrooms at all sites

- to continue tracking the impact of ACOT on students with assessments of students' achievement and students' motivation

- to develop and administer a questionnaire to assess the impact of ACOT on teachers

- to develop and administer a questionnaire to assess the impact of ACOT on parents

- to develop procedures for assessing students' growth in problem-solving (to be used in 1989-90)

- to develop a classroom observation instrument (to be used in 1989-90) to document changes in classroom process

Throughout 1988-89, our intent was to carry forward the essential structure of the 1988 evaluation plan while reviewing other measures for inclusion or substitution. We collaborated with ACOT teachers and with the Advanced Development Group of Apple Inc. in our efforts to adapt the evaluation to the evolving ACOT context. Thus,

- At two sites, an experimental version of the writing assessment was created to permit students to revise their essays on a second day, mirroring the writing method some students were using in their classroom assignments.

- At one site, teachers and UCLA staff collaborated in the writing of prompts for the writing assessment, so that the content of the prompts reflected the kinds of assignments that teachers typically assign and that teachers felt would result in students' best performance.

- At most sites teachers provided us information concerning the essay genre that received the most emphasis at each grade level, and we focused the selection of writing tasks on those genres.

- At the three sites with elementary level grades 2 through 4, we revised our methods of assessing children's writing competence by adopting an evaluation rubric constructed for the elementary grades. The IEA scales used in the prior year of our ACOT evaluation had provided us with a national comparison sample for Grades 6 through 10. The elementary rubric, developed from the same sources as the

IEA scales and validated by a California school district (Conejo Valley), provides us with a district comparison sample of Grade 3 students.

- At one site with primary grade children, the School Attitude Measure, normed for grades 4 through 12, was replaced with the Self-Concept and Motivation Inventory, normed for grades K-3. At this site, ACOT students in a grade below 4th completed both the SCAMIN and SAM, permitting us comparison of students' performance on both measures.

- New questionnaires for teachers were developed and distributed at all sites.

- A standardized measure of occupational stress, the Occupational Stress Inventory, was added to the measures of teacher effects and distributed to all sites.

- New questionnaires for parents were developed and distributed to all sites.

Additional work in classroom observation and in assessment of problem-solving was carried out in 1988-89 in preparation for continued expansion of the ACOT evaluation in 1989-90.

- Assessment of changes in classroom processes provide one level of explanation for any of the changes documented in student outcomes. We piloted both qualitative and quantitative procedures for documenting changes in classroom process.

- Teachers across sites commonly report that ACOT students are becoming better problem-solvers. In 1988-89, we collected a range of information from each site concerning teachers' problem-solving curricula and their perceptions of students' growth in problem-solving. Information included written descriptions of curricula, informal interviews with UCLA staff, and videotapes of children's problem-solving activities. These background data were the basis for the design of problem-solving tasks to be used in an assessment of elementary ACOT children's problem-solving competence.

Measures

Student Achievement

Iowa Tests. Our evaluation design called for a norm-referenced achievement test to be administered in 1987-88 and each subsequent year of ACOT evaluation, and the Iowa Tests of Basic Skills and the Iowa Tests of Educational Development were selected for this purpose. Compared with most other norm-referenced tests, we believe the Iowa Tests best allow us to compare students' performances across the many grade levels at ACOT. At the elementary level, we focused on 4 tests which reflect core emphases at most sites: Vocabulary, Reading Comprehension, Mathematics Concepts, and Work-Study Skills/Visual Materials. At the secondary level, we chose two tests: Vocabulary, and Social Studies.

Writing. All students responded to writing prompts that asked for either narrative, descriptive, persuasive, or expository writing. These prompts were derived from those used in the International Association for the Study of Educational Achievement (IEA) Study of Written Composition (Baker, 1987). The IEA study included national samples of students, but only in Grades 6 and 10. Therefore, ACOT students' essays in Grades 5 and up[2] (grades close to the grades assessed in the IEA study) were rated by specially trained raters who used rating scales also employed in the IEA study. These scales include ratings on Overall Impression, Organization, Content, and Style. (Detailed explanations of this system are included in Appendix A1). The results were compared with ratings for Grades 6 and 10 U.S. students in the IEA sample.

The essays of ACOT students in Grades 2-4 were rated with scales developed and used by Conejo Valley School District, a southern California district that has developed its own rubric (derived from the same sources as the IEA scales) for assessing the competence of its 3rd graders in narrative writing. Conejo Valley can be characterized as middle to upper-middle class in socioeconomic status, and we do take into account differences in population characteristics when we compare ACOT and Conejo performance.

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[2] There was one exception to this procedure. At one site, we collected writing samples from 'pre-ACOT' students who were in a grade below 5 but would enter the 5th grade in a subsequent year. For these students, we used the IEA scales to facilitate following their progress in future years.

Results for ACOT students were compared with those for Conejo Valley 3rd graders in narrative writing. (Detailed explanations of the Conejo scales are included in Appendix A2.)

Student Attitudes

Five approaches were used to assess student attitudes: 1) responses to a nationally normed measure (School Attitude Measure, for grades 4-8; Self-Concept and Motivation Inventory, for grades K-2); 2) ratings of students' attitudes toward computers in their persuasive essays on a computer topic; 3) responses of teachers to questionnaire and interview items concerning their perceptions of students' attitudes; 4) responses of parents to questionnaire and interview items concerning their perceptions of students' attitudes; 5) examination of student attendance and mobility patterns for sites that were able to provide us these data. Descriptions of the Teacher and Parent Questionnaires are found in later sections.

Nationally normed measures. *School Attitude Measure (SAM):* The SAM is a self-report survey instrument published by Scott-Foresman consisting of five scales: Motivation for Schooling; Academic Self-Concept, Performance-Based; Academic Self-Concept, Reference-Based; Sense of Control; and Instructional Mastery. (Details of the five scales are provided in Appendix B1). SAM is normed for grades 4-12 and was administered to all grades within this range. *Self-Concept and Motivation Inventory (SCAMIN):* The SCAMIN is a self-report survey instrument published by Person-O-Metrics, Inc. consisting of 4 scales at the early elementary level (Achievement Needs, Achievement Investment, Role Expectations, and Self-Adequacy). (Descriptions of the scales are included in Appendix B2.) It is normed for K-12 and was administered to all Grades below 4.

Students' attitudes toward computers in persuasive essays. Raters made a judgment that students felt either positively or negatively about computer use from the content of their persuasive essays on computer topics.

Archival data -- student attendance and mobility. Sites were asked to provide UCLA with attendance and mobility data for each student for 1988-89, 1987-88, and 1986-87. Compliance with our request varied across sites.

Teachers' Practices, Perceptions, and Attitudes

Two approaches were used to assess the impact of ACOT on teachers: 1) responses to a teacher questionnaire, 2) responses to a normed measure of occupational stress (the Occupational Stress Inventory).

Teacher Questionnaire. The Teacher Questionnaire focused on a range of topics, including curricular practices, perceptions of students' achievement, and perceived stress. (See Appendix C1 for a copy of the instrument, and C2 for the scheme used to analyze responses to open-ended questions.) At sites 1, 2, 3, and 5, both ACOT and Comparison teachers received the questionnaires; at site 4, only ACOT teachers received them. The rate of return varied markedly by site and group.

Occupational Stress Inventory (OSI). The OSI, published by Psychological Assessment Resources, Inc., is a self-report survey consisting of three dimensions of occupational adjustment: Occupational Roles, Personal Strain, and Coping Resources. Within each domain, there are a number of scales. Occupational Stress includes Role Overload, Role Insufficiency, Role Ambiguity, Role Boundary, Responsibility, and Physical Environment. Personal Strain includes Vocational Strain, Psychological Strain, Interpersonal Strain, and Physical Strain. Coping Resources include Recreation, Self-Care, Social Support, and Rational/Cognitive Coping. (See Appendix D for detailed descriptions of these scales.) The Personal Strain and the Coping Resources items were offered to teachers as optional.

Parents' Views, and Home Uses of Computers

A questionnaire was developed to assess the impact of ACOT on parents and the home.

Parent Questionnaire. The Parent Questionnaire focused on a range of topics, including parents' perceptions of the impact of ACOT on their children, parental aspirations for their children, and uses of the computer at home. (See Appendix E1 for a copy of the instrument, and Appendix E2 for a copy of the scheme developed to analyze parents' responses to open-ended questions.) At sites 2, 3, and 5, both ACOT and Comparison parents received the questionnaires; at sites 1 and 4, only ACOT parents received them. The rate of return varied considerably by site and group.

Data Collection Design and Procedures

Comparison groups. In 1988-89, all sites provided us with a comparison group. Two sites provided comparisons within the same school, although comparisons at one of these sites were available only for 2 of the 3 ACOT grade levels. Two other sites provided comparisons from another school, either within the same district or in a similar district nearby. The remaining site provided comparisons for one grade within the school and comparisons for another grade in another school within the district. Not surprisingly, the similarity between ACOT and comparison group characteristics varied across sites. At some sites, students were selected for ACOT by lottery from an applicant pool; since few (if any) of the rejected applicants were students in the comparison sample, the comparison students were likely to be different in their achievement, motivation, and family background.

Data collection. Data collection instruments and directions for their administration were mailed to ACOT prior to the time scheduled for administration. Note that this timing for the spring assessments pushed some of the data collection uncomfortably close to the end of the school year.

The order of administration for the spring student outcome measures was set to minimize the impact of the testing on reported attitudes and, to the extent possible, to provide variety in scheduled test activities. The order was:

1. School Attitude Measure
2. Writing
3. Iowa Tests

UCLA was responsible for ordering test materials and providing instructions. Site coordinators were responsible for arranging for administration, assuring adherence to requested procedures, and returning completed materials to UCLA. In general, regular classroom teachers served as test administrators for the writing measures, but some sites arranged for a special test proctor for the Iowa Tests and the attitude measures. Most sites complied in the administration of some or all of these measures. The comparison groups varied considerably in their willingness or ability to cooperate with all components of our study.

The Parent and Teacher Questionnaires and the Occupational Stress Inventory were distributed by classroom teachers or site coordinators in late spring. Some of the ACOT teachers provided incentives to students (e.g., special pencils) as a means to encourage parent cooperation. Two sites with comparison samples at different schools did not distribute the Parent Questionnaire, and one of these two sites did not distribute the Teacher Questionnaire or the Stress Inventory. As reported in relevant results sections, rates of return of these 3 self-report surveys varied considerably by site, grade, and group.

Sites were also asked to provide archival data on district achievement test results and absences for ACOT and Comparison students for the previous three years. Site compliance for this request was less than for the common student, teacher, and parent measures.

Data analysis. UCLA prepared all SAM, SCAMIN, and ITBS materials for machine scoring by the test publishers. Because most ACOT students used word processors to write their essays, all untyped essays were typed to assure that raters were unaware of a students' status as ACOT or Comparison. UCLA prepared the essays for rating by separating Grades 1-4 essays (to be rated with the Conejo Valley rubric) from Grades 5-11 essays (to be rated with the IEA rubric), deleting students' names, grades, and dates from each essay, and scrambling the essays within the IEA and Conejo groupings so that raters were 'blind' with respect to school, student's gender, grade, or date of completion. Responses to the close-ended items on the Teacher Questionnaire, Parent Questionnaire, and Stress Inventory were key-punched for quantitative analysis. Responses to the open-ended items were coded with schemes for qualitative analysis constructed from the responses themselves.

Results

Evaluation of the ACOT project is made difficult by the extraordinary diversity among its five sites in student characteristics, curriculum emphases and activities, parent and home characteristics, and nature of the comparison samples. In addition, district restrictions, scheduling conflicts, and site willingness confounded the administration of each of our measures across all

sites to both ACOT and Comparison groups, and leaving some gaps in our results.

In our results, sites are identified by number (1-5) rather than by school or district name. Because grade level and site are confounded, the letters A, B, and C are used to signify grades at a site. These letters are intended only to reflect lower (A) and higher (B or C) grade levels, and do not correspond across sites. For instance, at one site 9th grade would be labeled A and 10th grade labeled B, while at another site 1st grade is labeled A and 2nd grade labeled B. While somewhat more difficult to read, these decisions are consequences of our agreements to protect the privacy of the teachers and students at our sites.

All results reported below have excluded special education students, with the exception of Grade A at Site 2, a 'transitional' class of special education students not yet ready for Grade B at that site. Note as well that the letters used to designate grade levels in this 1988-89 report do <u>not</u> necessarily correspond to the same levels indicated in the 1987-88 report. Thus at site 2, for example, Grade B is in fact the same as Grade A in the 1987-88 report. These changes in grade identification resulted from either reorganizations of the ACOT project at certain sites or extension of our data collection to additional ACOT grades. Comparisons of last year's and this year's student results (using this year's indexing system at all times) are included in this report to minimize any confusion in comparing results across the two reports.

Grade levels sometimes reflect years in ACOT and sometimes do not. At site 1, almost all students in Grades A through C were in their first year of ACOT in 1988-89 (students were chosen by lottery for admission to ACOT in Grades A and B, but all students in Grade C were ACOT). At site 2, students are in ACOT for only one year, either Grade A (special education students) or Grade B. At site 3, the ACOT project expanded in 1988-89 to include the next lower grade, and thus students in both Grades A and B were new to ACOT, and students in Grade C were in their second year. Only at sites 4 and 5 does each successive grade indicate one more year in ACOT.

Student Achievement

<u>Iowa Tests of Basic Skills</u>. Sites 2, 3, 4, and 5 administered the Iowa Tests. The results for the Iowa Tests were examined in three

ways: group results for 1988-89 (percentiles based on mean grade equivalents) for each subtest (Appendix F), group comparisons of the 1988 samples with the 1989 samples (Appendix G), and repeated measures comparisons of students who took a test on two occasions (Appendix H).

A percentile score of 50 is the median of the national sample, the point below which half the national group fell and the so-called national average. Because percentile ranks are generated for each grade level, the reported scores control for age and grade level differences across sites. While 3 of the 4 cooperating ACOT groups are performing above the national norm (disregarding the special education Grade A at site 2), the data (Tables F1 and F2) verify the great differences among the sites in overall student academic achievement.

At three sites with Comparison results, ACOT students' scores were generally higher at each cycle of administration. However, most of these results appear to reflect pre-existing and fairly stable differences between ACOT and Comparison groups, with the possible exception of Site 4.

- Based on *1988-89 group performance* (Table F3), ACOT students are generally performing more competently on the Iowa Tests than the Comparison students. At site 2 there was a decline in ACOT percentile scores from fall to spring, particularly for Grade B, a possible reflection of exceptional stress in the spring when the building was undergoing extensive construction at the ACOT wing; nevertheless, the ACOT grade B students were still performing markedly higher than Comparison students.

- If we *compare 1988 scores with 1989 scores* (Tables G1 and G2), ACOT students at site 3 have tended to score higher than their Comparisons both years. At site 4, comparisons between groups is made difficult by changes in selection of the Comparison sample. In 1987-88, the Comparison sample was an entire school district; in 1988-89, only volunteer classrooms in that district participated (with few students in Grade A). Results indicate that at both grade levels the differences favoring the Comparison sample in 1987-88 were reduced or even reversed in 1988-89, a promising finding.

However, sampling differences (especially for Grade A) could also be an explanatory factor, making interpretation difficult.

- If we *compare ACOT and Comparison students' grade equivalent scores for students who took the ITBS on two occasions* (Table H1), the evidence suggests that differences in ACOT and Comparison classrooms are due to pre-existing and stable differences between the two groups. At sites 2 and 3, the growth of both groups at each grade for each test was often weak (less than the expected growth of .7 years for fall-spring and 1.0 years for spring-spring.) At site 4, the growth of the Comparison students for Grade B tended to be greater than ACOT growth. (The ITED does not provide grade equivalents, but based on group performance, Grade A students declined marginally from fall to spring (Table F3), and Grade B and C students (comparing them with their results as Grade A and B students last year, Table F2) also declined somewhat from 1988 to 1989.)

There is little consistent evidence that students with more years of ACOT experience were performing better than students in their first year (Tables G1 and G2).

- At site 3, the relative performance of Grades A and B (both first year ACOT) vs. Grade C (second year ACOT) shifted from test to test. At site 4, ACOT Grades A and B performed similarly (although Comparison Grade B performed somewhat better than Comparison Grade A). At site 5, Grade B tended to score higher than either Grade A or C.

Local district assessments. Results from district assessments provide additional evidence of pre-existing ACOT and Comparison differences (Tables I1-I3).

- District testing results (Appendix I) were provided by three sites. At Site 1 (Table I1), Comparison students for Grade B scored slightly higher than ACOT students on several SRA subtests. The Comparison students for Grade B at Site 2 (Table I2), consistent with the ITBS results at this site, scored markedly lower than ACOT students on Stanford tests. At Site 5 (Table I3), Comparison students have scored considerably lower than ACOT students on the Comprehensive Tests of Basic Skills.

Writing. We had several goals for our evaluation of students' writing competence: (1) follow students' growth from 1988 to 1989; (2) focus on assessment of the genres most emphasized at each site; (3) add an experimental version of the assessment that permitted students to rewrite their essays on a second day, to provide us both with an index of students' competence with the process of revision and with a more valid picture of writing ability. To accomplish goals (1) and (2), at each cycle of data collection (fall, winter, and spring of 1988-89), students were assigned to write on particular genres; no student, however, wrote on exactly the same topic more than once. Note also that when we assessed students' performance in more than one genre at any given time, we administered each genre to a sampling of students to reduce the number of different essays a student would have to complete. To accomplish our third goal, two sites agreed to administer first and second drafts in the winter, and one of these sites repeated this procedure in the spring.

All student essays were scored by one of seven raters. The Conejo Valley rubric 6-point scales were used for essays in Grades 2-4. The IEA 5-point scales were used for essays in Grades 5-11. (Note that at site 3 this procedure resulted in Conejo scoring for Grade A and IEA scoring for Grades B and C.) For both sets of ratings, reliability of the scoring process was assessed by computing the agreement among all combinations of raters for at least 20% of the essays in each genre. (When essays were double-scored for reliability, the score used in data analyses was the average of the two raters' judgments.) Interrater agreement (Tables J1 and J2) was high for both scales. Intercorrelations among the scales composing each rubric (Tables K1 and K2) were high, and we are therefore reporting only the results for General Competence/Conejo and Overall Impression/IEA. For essays that included the second draft option, we used only the first draft rating in our primary analyses.

The results for the writing assessment were examined in four ways: group results for 1988-89 (mean ratings, Appendix L), group comparisons of the 1988 samples with the 1989 samples (Appendix M), repeated measures comparisons of students who wrote on a genre on two occasions (Appendix N), comparisons of first and second draft ratings (Appendix O). We should stress that the amount of data collected was considerable and the number of variables examined was large (genre, time, grade, group), and therefore the

findings below of occasional differences in the context of the sheer number of comparisons should not be overinterpreted.

On the Conejo 6-point scales, a rating between 3 and 4 indicates competent performance; on the IEA 5-point scales, a rating of 3 indicates competence. Based on these criteria, the writing of many ACOT students is weak, although the results show a considerable range in students' performance across sites.

- For essays rated on the Conejo scale (*1988-89 ACOT performance*, Table L1), only students in Grade C at site 1 and Grade B at site 2 received mean ratings above 3 for descriptive (both sites) and persuasive (Site 2) writing. For those scored with the IEA scales (Table L2), only students at Site 5 received mean IEA ratings at 3 or above.

- There is, however, some evidence of growth with grade level (and years of ACOT experience) at Site 3 and Site 5.

- ACOT students did occasionally perform as well as the national norm group provided by the IEA Grade 6 and 10 students and the upper SES comparison group provided by Conejo Valley School District (*1988-89 ACOT performance*, Tables L3 and L4). Although we have only ratings of Conejo Grade 3 on narrative, our adaptations of the rubric for descriptive writing indicated that the Grade 3 students at Site 1 were writing almost as well as the Conejo students might have in this genre (Table L3). This is not a surprising result, in that the Site 1 population is more similar to Conejo than is Site 2 or 3. The persuasive essays of this Grade in the spring were also rated at a comparable level (Table L1). Grade 6 students at Site 4 were writing descriptive essays comparable to the IEA sample, and persuasive essays more competently than the IEA students. Grade 10 students at Site 5 were writing roughly comparable expository essays.[3] At various times during the year, students' writing in other genres equaled or exceeded IEA means (Table L2).

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[3] At this site, however, teachers participated in the writing of new prompts that better matched their instruction in all genres. These prompts were administered in the winter and spring of 1989, and we cannot determine to what degree teacher-selected prompt content may have supported the quality of students' writing.

Interestingly, the strengths that students displayed were not consistently those that sites indicated were emphasized at each grade level.

- We examined the results across genres for the spring outcome essays. The relatively even performance of students at Sites 2 and 4 is consistent with site descriptions of their curriculum (Tables L1 and L2). Site 5 reported expository emphasis for Grades B and C; since persuasive and expository essays are structured and assessed very similarly, the strength of the persuasive ratings is also consistent with site curriculum descriptions. However, descriptive and persuasive ratings are often higher than narrative for sites that reported narrative emphasis (Site 1, Site 3/Grade A, Site 5/Grade A).

These discrepancies could have several explanations, among them: mismatches between our and teachers' definitions of genre; the need for more focused instructional efforts; differences in prompt difficulty.

The writing results support again a finding of pre-existing and fairly stable differences between ACOT and Comparison groups, with ACOT-Comparison differences generally identical to those found for the Iowa and district achievement tests.

- Analyses of *1988-89 group performance* (Conejo/Table L5; IEA/Table L6) tend to show ACOT students performing better than Comparison students. Only Site 1 shows a possible contribution of the ACOT experience to students' writing competence.

The 1989 ACOT students tended to perform more competently than the 1988 sample at the same grade level.[4]

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[4] Comparisons of last year's and this year's ratings for Grades 2-4 cannot be direct, since last year's essays were rated only with IEA scales. However, results from an equating study (double-scoring with both the Conejo and IEA schemes) using a sample of the 1989 essays indicated very high correspondence between ratings on these scales, with 6/5 of an IEA rating equivalent to a Conejo rating. Therefore, to compare the 1988 and 1989 essays for two elementary grades that had also been assessed last year, we multiplied the 1988 IEA means by 6/5.

- Analyses of *group comparisons of the 1988 samples with the 1989 samples* indicated that students at sites 1 and 2 may have been writing more competently than their same-grade peers last year (Table M1). Similarly, the IEA ratings of students at Sites 3, 4, and 5 were higher at each grade level in 1989 than they were in 1988 (Table M2).

Although we have Comparison results only for Site 3, the essays of the Comparison students in Grades B and C were also rated more highly in 1989 than in 1988. This result casts doubt on any specific effect of the ACOT experience, and suggests the most conservative interpretation that provision of our tasks and rating schemes has been having an effect on writing instruction for both groups at all sites.

At most sites, students in both the ACOT and Comparison groups tended to perform as well or better over time.

- Analyses of *repeated measures comparisons of students who wrote on a genre on two occasions* reveal inconsistent trends across genres, sites, and grades (Tables N1-N6). Few changes were significant by statistical criteria.

As for the group performance results, these analyses suggest that our writing assessment is contributing to students' writing growth in both ACOT and Comparison groups.

Some students were able to improve the quality of their writing in their second drafts.

- Students' second drafts were generally rated more highly than their first drafts at Site 5 (the secondary site) (Tables O1 and O2).

Students' achievement: Summary and Interpretation. None of results for the achievement assessments indicates that ACOT is contributing to students' growth at a level beyond that of instruction in more conventional contexts. Differences between ACOT and Comparison students tended to be consistent across measures and time, indicating pre-existing and fairly stable differences between groups more than any direct effect of the ACOT experience.

Although many ACOT students were performing at or above the national median on the Iowa Tests and their district assessments, there was considerable variability across sites reflecting typical patterns of performance and growth in schools with comparable population characteristics.

Many ACOT students were not writing at the levels of competence defined by our assessment rubrics in all genres, but there was evidence of growth in that the 1988-89 students showed improvement over time. Both the ACOT and the Comparison 1988-89 samples were performing above the 1987-88 samples, a pattern which may indicate that our writing assessment itself was serving as an effective intervention. At several sites, selected grades were sometimes performing as well or better on some genres than our comparison Conejo and IEA samples. The writing data gave us a quite differentiated picture of students' growth over time and with grade level as well as relative performance among genres. However, once again the evidence best supported a finding of pre-existing and stable differences between ACOT and Comparison groups, and not an effect of ACOT. At only one site were there results suggesting that ACOT students may have been improving at a rate greater than their comparison peers.

Our experiment with assessment of writing process, through comparative ratings of first and second drafts, produced most provocative though preliminary results suggesting that secondary level students are more able to improve the quality of their essays in their rewrites. More systematic administration of this version of our assessment is needed.

Student Attitudes

In this section we report results from 2 normed instruments, the SAM (Appendix P) and SCAMIN (Appendix Q), ratings of students' attitudes toward computers in their persuasive essays on a computer topic (Appendix R), and patterns of students' attendance (Appendix S). Teachers' and parents' reports of students' attitudes are presented in sections on teacher and parent effects.

SAM. The results for the SAM were examined in three ways: group results for 1988-89 (percentiles based on mean weighted raw scores) for each subtest, group comparisons of the 1988 samples with the 1989 samples, and repeated measures comparisons of students

who took the test on two occasions. Problems with site compliance and errors in administration interfered with a number of these analyses.

Student responses to the SAM are reported in terms of national percentile scores, where 50 represents the score point below which half of the national sample fell. Most students' attitudes were approximately equivalent to or more positive than the national average.

- Analyses of *1988-89 group performance* (Table P1) indicate some diversity among ACOT students across sites. The somewhat lower scores of the special education class (Grade A) at Site 2 are not surprising given the population.

By statistical criteria, there were almost no differences between ACOT and Comparison students' attitudes at four sites.

- However, consistent with the achievement results, ACOT students in Grade B at Site 2 tended to report more positive attitudes than their Comparisons (Table P2). At site 5, Grade B ACOT students reported more positive attitudes than their Comparisons; since ACOT students' attitudes did not differ across grade levels, this result reflects the rather negative attitude of Grade B Comparison students and not an effect of ACOT.

The 1988-89 students did not appear to differ in their attitudes from 1987-88 students.

- *Group comparisons of the attitudes for ACOT students in the same grades in the spring of 1988 and in 1989* (Table P3) do not show consistent patterns across the four sites for which we have these comparisons. The attitudes across most grades at each site were similar.

The 1988-89 students did not appear to have changed in their attitudes since the spring of 1988.

- Consistent with the group results, *repeated measures analyses of the attitudes of ACOT students who took the SAM on two occasions* (Table P4) found few statistically significant changes over time, and these were small in size.

SCAMIN. The SCAMIN was administered only at Site 1, where students' grade level rendered the SAM (normed for grades 4-12) inappropriate.

- Results from the SCAMIN for students at Site 1 (Table Q1) indicated somewhat more negative attitudes than any of our results for the SAM at any site. Nevertheless, most scales of the SAM were correlated with most scales of the SCAMIN for the small sample of students who were administered both assessments (Table Q2), suggesting that both instruments were assessing similar affective domains.

- The only SCAMIN scale which did not correlate with the SAM, Achievement Investment, also produced the only difference between the ACOT and Comparison students at Site 1. This scale is intended to indicate students' concern to avoid consequences of failure in school.

Students' attitudes toward computer use in persuasive essays[5]. Both ACOT and Comparison students at all sites expressed very positive opinions of computer use in their essays.

- The majority of students in all groups across sites wrote favorably about computer use in schools (Table R1).

Attendance. Table S1 contains patterns of student attendance from 3 sites. Results across sites and grades are inconsistent.

- At Site 1, attendance was somewhat less for ACOT than Comparison students, but at sites 2, 4, and 5, attendance was a bit greater for ACOT students. These differences at Site 5 have been consistent over time, reflecting probable sample differences rather than an ACOT effect.

Student attitudes: Summary. Based on results from normed attitude measures, content analyses of students' essays of computer use, and patterns of student attendance, the ACOT project is neither undermining students' interest and motivation, nor is it enhancing the affective aspects of their school experience beyond that of their

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[5] Interrater agreement, based on double-scoring of 20% of all persuasive essays, was 96%.

peers. It is of note that ACOT students do not appear to be tiring of their interest in the innovation. Most ACOT and Comparison students reported generally positive attitudes toward schooling and toward computer use.

Teacher Effects

In this section we report the results of two instruments, the Teacher Questionnaire and the Occupational Stress Inventory.

Teacher Questionnaire. Our efforts at analysis were limited by an uneven rate of return across sites and groups (Appendix T, Table T1). The number of teachers responding to the questionnaire was not high, and therefore we combined teachers across sites, separating them by lower elementary (grades 1-3), upper elementary (grades 4-6), and secondary (grades 9-12). Still the number responding was low for certain combinations of levels and groups: there are few comparison teachers for lower elementary and secondary levels, and at the upper elementary level, most of the ACOT teachers are from a different site from most of the Comparison teachers. We therefore avoid making comparisons between ACOT and Comparison teachers.

Below our analyses are divided into topical areas covered in the questionnaire. Analyses of the questions administered to all teachers are contained in Appendix U. Analyses of the responses to the open-ended questions administered only to ACOT teachers are contained in Appendix V. One rater scored all open-ended responses using the schemes detailed in Appendix C; to establish reliability, a second rater scored 20% of the sample distributed across sites and groups. Agreement was excellent: 100% for responses to all questions with the exception of 83% for teachers' new expectations for students.

Curriculum emphases: Reported curricular time allocations showed great variability across grade and group (Table U1). We question the uniformity of teachers' interpretations of these items. We also note that certain subject categories (e.g., 'Reading') fit elementary level curriculum better than secondary curriculum.

Nature of classroom assignments. Based on teachers' reports, the most common kind of classroom assignment for teachers at all levels was a brief, one-day assignment (Tables U2-U4), although

secondary teachers, consistent with the advancing maturity of their students, reported assigning these somewhat less often.

- Correspondingly, secondary teachers assigned three-day assignments in more subject areas more frequently than elementary teachers. Note however that elementary teachers assigned 3-day writing assignments fairly frequently (2-4 times per month), and upper elementary teachers also assigned 3-day reading assignments this frequently. All other assignments were much less frequent at every level. Not surprisingly, it was in science that students were relatively more often engaged in projects and exhibits.

Student role in assignment completion. Most teachers tended to report that they assigned students specific independent work more often than providing choice (Table U5).

- However, students were given some choices with reasonable frequency, at least in some subject areas. Students were fairly often given choices among several assignments, particularly in writing, and were also given choices of the order in which they could complete assignments.

Classroom groupings. Typical of most elementary instruction, ACOT elementary teachers reported organizing an average of 2 or 3 reading and math groups in their classrooms (Table U6). Students were reported to work together in pairs or cooperative groups with moderate frequency and to assist one another at all levels, although the subject areas organized for peer involvement varied across levels.

Homework. Teachers at all levels reported that they assign homework and that most students complete it (Table U7).

Teachers' satisfaction with students' academic and socioemotional progress. Most teachers were quite satisfied with their students' academic and socioemotional progress (Table U8).

- The ratings of the lower elementary teachers tended to be the highest across all areas, and the ratings of the secondary teachers tended to be the lowest across all academic areas except computer skills. Most teachers were quite satisfied with their students' attitudes toward school and self-

confidence. Upper elementary teachers expressed mild concerns about their students' independence and cooperative skills.

Teachers' job-related growth and stress. Most teachers reported experiencing challenge and growth with great frequency (Table U9). Teachers' perceptions of support varied, with a tendency to feel more support and recognition from their team teachers than from other teachers or principals.

- Most teachers reported experiencing personal stress from their work occasionally or often, although the frequency of reported stress was somewhat less than the frequency of reported challenge and growth.

ACOT -- a context for curricular revisions. In optional, open-ended questions, some ACOT teachers reported developing higher expectations for students since ACOT (Table V1), particularly for greater student achievement and for acquisition of computer skills.

- Teachers at the secondary level were most likely to report enhanced expectations for students' abilities to participate responsibly as a result of ACOT experience. Some ACOT teachers remarked on a variety of new ways of using computers for instruction (Table V2), including uses of applications, ways of integrating computer use into specific subject areas, uses of computers for encouraging cooperative work, and (infrequently) individualization of curriculum.

ACOT teachers' views of the effects of ACOT on themselves. ACOT teachers were asked about the positive (Table V3) and the negative (Table V4) impact of the ACOT experience on them. Respondents took the opportunity to describe a wide range of effects. Teachers often remarked on the value of computers in their teaching and the positive impact on their job interest and performance.

- Teachers at higher levels were more apt to mention benefits for improved teacher and student roles. Teachers at the upper elementary level were most apt to mention positive effects on their feelings of self-worth and their appreciation of the opportunities to travel and to meet new people. But teachers also expressed concerns. Some expressed worries

about curriculum coverage, and many reported stress and demands on personal time.

Questionnaire wrap-up -- ACOT teacher's views of the strengths and weaknesses of ACOT. ACOT teachers were also asked about the strengths (Table V5) and the weaknesses (Table V6) of the ACOT project. Their responses highlight some of teachers' most salient feelings about ACOT. In describing strengths of the ACOT project, many teachers remarked on ACOT colleague relationships.

- Additional strengths mentioned varied somewhat across levels, with a lower elementary focus on student affect and an upper elementary/secondary focus on student-teacher roles.

In describing weaknesses of ACOT, teachers focused most often on unproductive staff relationships and on concerns for curriculum coverage.

Occupational Stress Inventory (Appendix W, Table W1). We could not break down the Occupational Stress Inventory results by site or by elementary/secondary levels, because the scales are normed separately for men and women, and therefore the number of respondents in any category for either gender would be too low for meaningful analysis. Very few teachers completed the inventory in any case, and most who did completed only the requested Occupational Roles section.

Note that the scales clustered under Occupational Roles and Personal Strain are interpreted differently from those under Personal Resources. A higher percentile within the first two clusters indicates greater perceived stress; a higher percentile within the last cluster indicates perception of greater personal resources.

The ACOT teachers who responded to the OSI reported stress comparable to many adults (i.e., around the 50th percentile compared with a sample of adults drawn from a wide range of occupations), with the exception of relatively higher stress reported for Role Overload, and Physical Environment. Items in the Role Overload scale indicate heavy workload with feelings of insufficient support or training to meet the work demands. Items in the Physical Environment scale indicate environmental interference (e.g., noise, light, heat/cold), erratic work schedules, or isolation.

Teachers: Summary and Commentary. The distribution of Teacher Questionnaire and OSI returns greatly limited the inferences we could draw from the results. In particular, we were not comfortable comparing ACOT teachers with their Comparison colleagues. In addition, 1988-89 was the initial year for collection of these data, and we are therefore unable to use analyses of changes over time to help clarify the source of any ACOT-Comparison differences. These limitations make it virtually impossible for us to identify ACOT effects on either classroom practices or teachers' experience and attitudes.

ACOT teachers' reports of their classroom practices indicated, for each level, fairly typical subject matter emphases, classroom organizations, and student roles. We acknowledge, however, that our questionnaire items, most of which requested either ratings (e.g., of frequency) or numerical assessments (e.g., of time) may not have been sensitive to other subtle changes in ACOT classroom practices. ACOT teachers appeared fairly satisfied with their students' progress, although secondary teachers tended to express less satisfaction than elementary teachers. Curriculum becomes more differentiated and complex with advancing grade levels, and it may be that the necessary elaboration of teachers' objectives results in more acutely examined progress among their students. Results from all other measures indicated that ACOT has had considerable personal and professional impact on teachers. Although all teachers (including Comparison teachers) appeared to feel challenged and growing, as well as somewhat stressed by the demands of their job, these effects seemed more marked for the ACOT teachers. ACOT teachers remarked on a variety of benefits of the ACOT experience, for themselves as professionals and for their students, and appeared to be constructing new interpretations of their own and their students' abilities. Secondary ACOT teachers, in particular, consistent with the relatively advanced levels of competence of their students, appeared to be most actively revising their notions of students' roles in their own learning.

Effects on Parents and the Home

This section contains the results from the Parent Questionnaires as well as teachers' descriptions of parent involvement reported in the Teacher Questionnaire.

Parent Questionnaires. Appendix X (Table X1) contains the rates of return for sites and groups that distributed the Parent Questionnaires. Parent compliance varied considerably across grades, groups, and sites.

Below our analyses are divided into topical areas covered in the questionnaire. Results from the close-ended questions are contained in Appendix Y. Results from open-ended questions administered only to ACOT teachers are contained in Appendix Z. One rater scored all open-ended responses using the schemes detailed in Appendix E; to establish reliability, a second rater scored 20% distributed across sites and groups. Agreement was excellent: 96% for Child Benefits, 98% for Child Disadvantages, 90% for Parent Benefits, and 100% for Parent Disadvantages.

Background. Family characteristics: Some of the respondents were willing to share some background information about themselves (Table Y1). The results make clear the diversity among the sites in characteristics known to be related to student achievement, including parents' educational and occupational levels.

- Consistent with our own perceptions of the sites, the indices were quite high at site 1 and quite low at site 3, with other sites ranging in between.

This pattern of site difference in parents' reports was evident in many of the the analyses.

Parents' aspirations. Most of the parents who responded to the questionnaire hoped that their children would acquire some level of post-secondary education and expected that to happen (Table Y2). Similarly, most parents expected their children to work as skilled workers or as managers. There was some variation across sites and groups.

- Both parents' aspirations and expectations tended to be consistently high at Site 1, where levels of parental education, occupation, and income are relatively high. Where we have comparison results, ACOT parents' expectations both for their children's education and career tended to be higher (with the exception of Site 3, Grade B), although the number of comparison respondents is low in most cases.

Parents' involvement. Parents across sites, grades, and groups reported a low to moderate level of involvement with their children's school (Table Y3).

- At Site 1, involvement was somewhat greater at earlier grades, a pattern typical in the primary grades. At most sites, parents of children in older grades reported greater knowledge of the school than parents of children in younger grades. Teachers' reports of parental involvement (Table Y4) were generally consistent with parents' reports. The results suggest greater attendance at school functions by ACOT than Comparison parents, although the apparent ACOT-Comparison difference at the Upper Elementary Level must be disregarded, since most of the teachers in the ACOT group were from a different site from most of the teachers in the Comparison group.

Parents' satisfaction with their children's teacher. Most parents were highly satisfied with their children's relationship with their teacher (Table Y5).

- Parents at Sites 4 and 5 tended to report lower levels of satisfaction than parents at the other sites. Parents of upper elementary and secondary students may have developed more differentiated goals for their children's education, and therefore more critical views, than parents of younger children. ACOT parents at Site 3 may be less satisfied with the extent to which the teachers 'press' their students to achieve (although the rate of return at this site was often low).

Parents' satisfaction with their children's academic and socioemotional progress. Parents of ACOT children from all sites tended to report moderate to high levels of satisfaction with their children's progress (Table Y6). Progress in computer skills was generally very highly rated, but sites (and grades within sites) varied in relative ratings across subject areas.

- At Site 1, parents' satisfaction in most areas tended to decline with grade level. At site 3, parents of students in Grade C (their second ACOT year) tended to be less satisfied in most areas than parents of students in Grades A and B (first ACOT

year). The ratings of students' socioemotional progress tended to be lower at Site 4 than at other sites.

Interpretation of differences between ACOT and Comparison parents' satisfaction was limited by the small number of comparison respondents.

- Comparisons are available only at Sites 2 and 3 (Table Y7). (Although comparison parents at Site 5 returned the questionnaire, almost none of them completed these items.) At Site 2, ACOT parents reported greater satisfaction with their children's academic progress in several areas. The same trend appeared at site 3 in the results for Grades A and B (first year ACOT), but, in contrast, Grade C ACOT parents were generally less satisfied than the Comparison parents.

Parents' views of their children's interest in school at home.. Table Y8 contains ACOT parents' reports of the frequency with which children engaged in, or talked about, school activities at home (lower numbers indicate greater frequency). Parents generally reported that their children were showing some interest in school activities once or twice a week, although children expressed those interests in different ways at different sites and different grade levels.

- Certain grade level differences (homework and use of school software for ACOT students) reflect the increase of assigned homework at higher grade levels. Where there are comparison results, ACOT parents tended to report more frequent evidence of school activities at home than did comparison parents (except at Site 5, Grade C). This result is not surprising, since the presence of an identical computer both at home and at school would be expected to increase the possibility and therefore the likelihood of school-like home activities.

Parents' reports of children's home activities. According to parents' reports (Table Y9), children across sites, grades, and groups spend their time in somewhat different but predictable ways.

- Television watching is common among all children, but less common for Site 1 (primary grades, high socioeconomic level) and Site 5, Grade C (upper secondary level, with increasing demands on time from homework and part-time jobs).

- As expected, homework time tended to increase with grade level, and of course ACOT children used home computers more than Comparison children.

- Reported patterns of children's reading were not clearly related to site, grade, or group.

- At site 3, there was a suggestion that ACOT children in Grades B and C may have watched less TV, played less team sports, played outside less, and visited with friends less. If these results are valid, they may reflect pre-existing differences between groups rather than an effect of ACOT.

ACOT parents' reports of home computer use -- Hours per day. ACOT children were the most frequent users of the home computer (Table Y10).

- Children at Sites 3 and 5 appeared to spend the most time at the computer. The lower socioeconomic level of Site 3 is likely to have contributed to the novelty and therefore more frequent use of the home computer; Site 5 (secondary level) students were assigned homework on the computer nightly.

- Parents reported quite frequent use of the home computer by other family members as well. Parents of secondary level students (Site 5) were the least likely to use the computer. We cannot determine from this result whether the homework demands on Site 5 students interfered with adult use, or whether other dynamics in these adolescents' homes resulted in less interest or access for parents.

- Siblings and friends of Grade B, Site 3 children were the most likely to use the computer, reflecting again the lower socioeconomic level at that site and the inviting interest that a new home computer must have provided the other children in the ACOT's family and neighborhood.

Changes in uses of the ACOT computer over time. At most sites, parents reported that over time the home computers were being used more hours per week and for more uses, particularly for ACOT children, suggesting that a 'novelty' effect was not common (Table Y10).

Uses for the ACOT home computer. The pattern of uses for the computers revealed differences in students' interests and competences across sites, grades, and groups. Common uses for ACOT children (Table Y11) were games, homework, practicing, personal writing, and graphics. (We are not certain that all parents gave 'programming' the same definition.)

- There was a greater variety of children's uses reported by parents at Sites 3, 4, and 5 (upper elementary and secondary levels) than Sites 1 and 2 (primary and middle elementary levels).

Reported uses by ACOT children's siblings and friends (Table Y12) were spread more thinly across categories at most sites, but there was evidence that it was not uncommon for siblings and friends to use the computer for personal needs such as homework and writing, as well as for recreation in games and graphics.

- The finding that siblings and friends were using the home computer to do homework at Sites 1, 2, and 4 may reflect the greater likelihood that the ACOT high school students (Site 5) were using the computer during typical homework times.

Parents' reports of their own uses of the computer (Table Y13) were quite diverse. The more commonly reported uses included personal writing, practicing, finances, and games.

- Parents at Site 1 tended to use the computer for more purposes than parents at other sites, while parents at Site 5 tended to use the computer infrequently and for fewer purposes.

ACOT children's assistance with home computer use. Some parents reported that their ACOT children had provided computer assistance to them (Table Y14). The frequency reported was not high, ranging on average from less than once a month to 2/3 times per month.

- Assistance was most frequent at Site 3, where parents would be the least likely to have had prior exposure to computers. Children provided assistance in a range of contexts, from games to word processing to graphics. Children in older

grades tended to be more likely to help their parents with more specified applications such as spreadsheets and databases.

ACOT parents' views of the effects of ACOT on their children. Because the distribution of parents who completed the open-ended questions was very uneven across grade levels, we collapsed analyses of open-ended responses within sites across grades. In their responses to open-ended questions (Table Z1), parents were more likely to comment on the benefits of ACOT for their children than the disadvantages. The most common responses concerned the importance of computer literacy and observations of better attitude toward schooling and improved school performance.

- Parents of children in primary and middle elementary grades (including the lower socioeconomic samples of upper elementary children at Site 3) were more likely to comment on ACOT's effects on children's attitude than were parents of upper elementary and secondary students.

But some parents also expressed concerns for their children, focusing particularly on areas of the curriculum that parents felt had not received sufficient attention in 1988-89.

ACOT parents' views of the effects of ACOT on themselves. Parents were less apt to discuss the benefits of ACOT for themselves (Table Z2), but there was some fairly common appreciation for the opportunity to use a computer at home, and, primarily at site 2, mention of positive effects on family interactions. Few parents remarked on any disadvantages of the ACOT project for themselves. The relative infrequency of parents' comments about themselves may indicate that ACOT had not yet had widespread impact on parents and/or that parents' greatest concerns when responding to the questionnaire were with the impact of the computers on their children.

Parents: Summary and Commentary. The uneven distribution of parent respondents across sites, grades, and groups limited our analyses particularly of comparison samples. In addition, 1988-89 was the initial year for collection of these data, and we are therefore unable to use analyses of changes over time to help clarify the source of any ACOT-Comparison differences. These limitations, as for the

Teacher Questionnaire, limit sharply our ability to infer ACOT effects on parents' views or home activities.

The ACOT parents who participated in our questionnaires and interviews appeared to share fairly high aspirations for their children and to be only a somewhat active group at school. Parents were generally satisfied with their children's progress, although there were differences across sites which appeared to reflect parents' evolving views of education as their children advance with grade level. There was some limited evidence, given our small comparison sample, that ACOT children may continue school activities at home more often than Comparison children, a result mediated, we suspect, by the common presence of the computer in both contexts. Time spent by some ACOT children in social and physical play as well as TV watching may be less than comparison children -- but these results, if valid, may reflect the kind of child whose parents would apply for ACOT participation. ACOT children were the most frequent users of the home computer, but other family members and friends used it with some degree of frequency. There were interesting effects of site for these results: the computers were used by more persons for more time at Site 3 (lower socioeconomic level) where few homes would have a computer, and computers were used more exclusively by the ACOT child at Site 5 (working class, secondary) where students are assigned considerable homework and are encouraged to develop marketable computer skills.

The computers appeared to be increasingly integrated in home activities, particularly by the ACOT child, with only occasional reports of fading interest for adults and other family members. Older children used the computer for more purposes than younger children, and most users used the computers for games, personal writing, practicing, and graphics. Adults at Sites 1 and 5 were the most different from one another in their patterns of use, reflecting perhaps the relatively highly educated sample at Site 1, and the less educated sample who were also parents of adolescents with homework and with needs, perhaps, to establish the computer as 'theirs' and that might discourage and even intimidate parents from efforts at computer literacy. The finding that many parents did report contexts in which their children had provided them assistance does suggest that a computer can be a context which may challenge established parent-child relationships in some households.

Parents were generally supportive of the ACOT project, and felt that it had benefited their children in any of several ways, including their children's knowledge of computers, attitudes toward learning, and achievement. But there were also concerns expressed about possible trade-offs in curriculum coverage. Some parents commented that the ACOT project had benefited them, particularly by providing them with the use of a computer. Few parents reported any disadvantages for themselves.

Implications of the Results

In this section, we will discuss the implications of this report for understanding the effectiveness of ACOT and for planning future assessment efforts.

Understanding the Effectiveness of ACOT

Our approach to the study of ACOT effectiveness has been one of triangulation. Recognizing the imperfections of existing measures and the scientific constraints on the real world laboratories in which ACOT is implemented, we are employing a strategy to assess progress based upon a range of measures and multiple benchmarks. Comparisons of ACOT students' basic skills performance to nationally reported norms is one approach; comparisons of student progress and achievement over time is another; comparisons of ACOT classrooms with demographically similar classrooms is still another information point; gathering data on classroom practices and parents' background characteristics to help explain and statistically adjust student outcomes is yet another. Our strategy is inherently developmental. We could not know at the outset the sets of measures most sensitive to technology-based interventions. We started with standard measures and now have extended our efforts to include the development of an expanded set of measurement tools to capture ACOT as it evolves. Thus, developing alternative measures of classroom process and students outcomes has been and continues to be a key component in our assessment strategy.

At this early stage, our study cannot provide firm conclusions about the effects of ACOT on student and other outcomes. Nor do we regard this information as central at this point. To recount some of the ongoing constraints of the study: ACOT is implemented in a relatively small number of classrooms, often only one at a particular grade level, dispersed in the original ACOT design over a diverse set

of school sites. ACOT effects are confounded by teachers' influences, curriculum selection, school ambiance, and the characteristics of students, among other things. Participation of comparison classrooms in our study has been and continues to be problematic. Nonetheless, we believe some inferences are possible.

The majority of our results thus far suggest that ACOT students have at least maintained their performance levels on standard measures of educational achievement in basic skills and have sustained positive attitudes as judged by measures addressing the traditional activities of schooling. Generally, the ACOT program appears at least as effective in promoting commonly measured student outcomes as the more typical instructional programs provided by the comparison sites, and in at least one site there are indications of advantage for ACOT students.

How should such maintenance of the status quo be evaluated? We believe there are reasons to view it positively. First, it is clear that the ACOT environment differs enormously from traditional classroom practice and that it requires adapting to a host of new technological possibilities. For example, student time spent in learning word processing and other software is time that otherwise would be spent on traditional school subjects. Similarly, the time teachers need to acquire technology skills and familiarity with supportive software might result in less time spent in curriculum planning or instruction of certain skills. Some trial and error might be required to arrive at the software that is most appropriate and matched to individual and/or grade level needs or most effective for attaining given objectives, not to mention the time loss and frustration that result from occasional technical failures. Any of these short-term problems could result in less-than expected student academic growth or a temporary undermining of students' motivation and attitudes. These negative consequences on student outcome have not been observed. Second, and more significantly, the experience of ACOT itself appears to be resulting in significant new learning experiences for students and greater attention to complex, higher level processing. Because more time in complex problem solving may translate into less time in basic skills instruction, some decrement in basic skills test performance also might be expected. From both these vantage points, then, maintenance of pre-ACOT performance levels could be viewed as an accomplishment.

Beyond maintaining performance on standard indicators, ACOT sites also show promising evidence of effectiveness in significant areas of education which are not well assessed by traditional measures: The non-standard measures which have been used by the study, assessing higher level outcomes and important dimensions of instructional process, reveal promising findings for future exploration. In two sites assessments of students' writing indicates substantial progress both over time and in comparison to similar groups of students. Our site visits and preliminary classroom observations, furthermore, suggest that ACOT is having positive and meaningful effects on the nature of instructional processes in participating classrooms. These instructional effects could be expected to produce significant outcomes, outcomes which again are not well represented by standard measures. For example, there are indications that some ACOT classrooms feature greater emphasis on complex, higher level cognitive tasks, on student initiative and on cooperative group activities than do traditional classrooms. As we use our newly developed observation protocol to validate these impressions, we are simultaneously moving forward in developing new measures to better tap the likely outcomes of such changes.

Student attitudes is another area where we have impressions of ACOT-related gains but have experienced some frustration with existing measures. The nationally normed measures we have used are the best available for group administration. Nonetheless, we and most measurement experts have serious reservations about the validity and reliability of currently existing scales dealing with such affective domains as motivation, responsibility, and student self-concept. Further, the measures we have used focus on traditional school contexts and activities. Because the measures do not reflect the technology-rich environment of ACOT, interpretation of student responses is difficult. For example, do student responses represent reactions to traditional school activities as they have experienced them in the past or to technology-rich activities as they are experiencing them in ACOT? Again, observations in some classrooms suggest positive, affective impact -- e.g., in engagement, commitment, pride in quality, but new approaches to measurement are required to document them.

Future Directions for ACOT Assessment

ACOT is a living laboratory in which the innovative possibilities of technology in schools are explored and refined. One of the

important strengths of the program is that it enables continuing experimentation with new possibilities, stimulating new goals, alternative instructional processes, and new outcomes for students. Its evolutionary character presents a special assessment challenge: the valid assessment of ACOT requires both close-up interaction with sites to understand the nature of changes which are occurring and new tools which can capture the unique changes and complex outcomes which are being produced. The insufficiency of standard measures for assessing such change is one clear conclusion from our assessment efforts to date. Thus while we will continue to monitor and document the effects and impact of ACOT in the two longitudinal research center sites (LRC), we also will continue to devote substantial attention to creating new measurement tools which can adequately represent instructional transactions and complex project outcomes as they evolve. In the process, ACOT may well become not only a national model for technology use in instruction, but a national model for innovative assessment of both technological and instructional effects.

Our innovative assessments draw on technology both as a stimulus to complex educational outcomes and as a medium for more effective measurement of those outcomes. Our recent and on-going efforts at developments of alternative assessments benefit from our experience as the national center for research on assessment and our understanding of technology in schools:

A new mirror for the classroom. In 1988-89 we developed a new classroom observation instrument designed to capture the effects of technology on classroom instruction. The instrument focuses on the nature of the instructional tasks in which students are engaged, documenting cognitive, social, and affective dimensions of each task transpiring during given observation periods. Observation categories include subject area of instruction; social organization; the nature of materials which are given to students; the nature of the responses students are asked to produce; resources in use; the role of adults; and apparent affective responses to each task. Appendix AA contains the observation form developed (AA1), and the manuals for use at the elementary level (AA2) and the secondary level (AA2).

The instrument is being used in 1989-90 at the two LRC ACOT sites. A primary function of our 1989-90 data collection is to begin the empirical documentation of commonly reported changes in the classroom practices of high access environments. Researchers and

educators seem to agree, for example, that computer use leads to more time on task, greater student motivation, more peer assistance, less directive teaching and more teacher facilitation, and more frequent group projects. However, prior to ACOT there has been little empirical documentation of these changes.

A hypermedia measure of knowledge representation. Among the two most visible movements in educational innovation are technology and assessment. Both represent the increasing call for educational reform – technology as an approach to improve instruction and management; assessment as an instrument to measure progress. Yet, so far these processes have linked up in relatively limited ways, and we need to work toward constructing new relationships between instructional uses of computers and improved approaches to assessing student performance. The questions we must address include: How should assessment adapt to the realities of classrooms in which technology plays a major role? Can we move beyond the surface features of performance assessment? Can technology itself offer opportunities to assess learning with new levels of cognitive and instructional validity?

There are few ways that educators are able to access students' understanding of complex phenomena, and almost all of them have serious drawbacks. Our hypermedia assessment project is an outgrowth of a long-term, Department of Education-funded study of the assessment of deep understanding through the use of extended student essays. Results of prior studies (Baker, 1988; Baker et al., 1990) found that deep understanding of a subject was demonstrated by essays that were premise-driven, elaborated with text-specific and prior knowledge, and exhibited significant levels of interrelationships among facts, concepts and principles. Nonetheless, the quality of student verbal expression interacted with raters' ability to assess knowledge possessed. To investigate whether HyperCard representations could provide a more direct measure of students' understanding, the ACOT assessment study used HyperCard as a knowledge representation device for eleventh grade students. Students used a specially-designed stack to construct concept maps of Depression era history knowledge before writing essays on given topics. Scoring schemes for analyzing these HyperCard products are being developed. If successful, they may supplement or substitute for essay measures of deep understanding.

New measures of problem-solving. The interactive, responsive, and flexible character of computer use provides an inviting context for learning problem-solving skills. Many elementary level teachers have been attracted to instructional software packages that are designed to foster higher-level reasoning abilities, such as collection, organization, and appropriate use of information when making inferences. Because there is a conflicting body of evidence in psychological and educational research on the transfer of cognitive skills from one subject matter to another -- and thus limited potential usefulness of isolated problem-solving practice, we felt it was important to document what kinds of gains, if any, could be demonstrated from use of problem-solving software.

Based on 1988-89 field observations and teachers' descriptions of their problem-solving instruction, we designed tasks for solution both on-computer and off which were structurally and functionally similar to those practiced frequently at certain elementary ACOT sites. We are administering these tasks twice during 1989-90 (fall and spring) to a sample of ACOT and Comparison children who have been rated as either high or low in academic ability at one of two different grade levels. While we expect the results of the study to provide useful feedback to users of instructional problem-solving software, we also view the study as a model approach to the assessment of cognitive outcomes, one that stresses carefully motivated tasks based on documented classroom practices.

Systematic assessment of student portfolios. There is a dramatic movement in the field of educational measurement to go beyond standard, multiple choice tests to develop measures which better represent instructional outcomes and enable students to demonstrate skills. One major facet of this interest is the assessment of student portfolios. ACOT provides a unique opportunity to investigate how to systematically assess student portfolios, starting with those comprised of writing samples. In 1988-89 we collected from several sites examples of student writing as well as information from teachers about their writing curriculum. Based on this fieldwork and informed by knowledge of our colleagues' portfolio assessment efforts, we designed a portfolio evaluation procedure which we are implementing at the elementary level LRC site in 1989-90.

The portfolios will contain monthly samples of students' 'best' writing in two genres that are emphasized at this site, as well as

samples of other projects that a student chooses to include. ACOT teachers are collaborating with UCLA's on-site researcher, in developing criteria for inclusion as well as procedures for documenting the instructional process that preceded the final product. The resulting data set will contain: a series of writing samples to be evaluated on scales (to be developed) of writing competence; a set of student-selected projects that will inform our understanding of the students' views of their ACOT experience; and documentation of teachers' methods of writing instruction. The project offers opportunities for collaboration with Ohio State University researchers who will be exploring the bases for students' personal choices and the effects that opportunities for choosing, reviewing, and sharing portfolio selections can have on students' views of schooling and of themselves as learners.

There is exciting potential for portfolios in all subject areas, in multisubject thematic areas, and in hypermedia formats. The ACOT sites will provide us unique contexts for exploring these possibilities. Although our initial effort will be devoted to collection and analysis of 'hard copies' of written work, we will be working toward computer-based portfolios. The range of product types that can be stored in hypermedia formats is virtually unlimited -- from written samples (scanned if handwritten), to art work (again scanned if not computer-based), to video, to audio, to HyperCard reports. Not only do we have access to technology and hypermedia software for storing and organizing students' work at ACOT sites, but many of the ACOT students' projects are themselves hypermedia products that are obviously most effectively displayed, reviewed, shared, and evaluated in a hypermedia format.

Other non-cognitive measures. Sensitive assessment of the effects of ACOT as well as other innovations in educational technology requires a varied measurement tool kit to capture a full range of high probability changes. Changes in students' attitudes -- their persistence, independence, pride in work, among other attributes -- are not only informally observed effects of ACOT but subjects of continuing national dialogue on this country's productivity and future competitiveness. Devising better measures of these constructs, likely grounded in observational, performance-based instruments, will be a continuing interest of the ACOT assessment component, an activity which will benefit from joint funding from the U.S. Department of Education.

A Unique Opportunity for Sensible Technology Assessment

We have repeatedly stressed that the assessment of ACOT requires continuing attention to new goals, new modes of instructional transaction, and new outcomes as they evolve. New tools are required to document and evaluate the complex effects of the ACOT; existing measures simply are insufficient to the task.

ACOT presents an unparalleled opportunity to develop these new tools: it is an environment of innovation that explores the possibilities of technology in improving educational processes and outcomes. It is a laboratory also both for analyzing those processes and outcomes and for exploring the use of technology in the analysis process. In so being, ACOT can contribute to the improvement of instruction, the meaningful assessment of its effects, and to informed decision-making about effective innovation.